STUDY OF AIRPOWER

UNIVERSITY
OF MICHIGAN

JUL 27 1956

MAIN
READING ROOM

HEARINGS

BEFORE THE

SUBCOMMITTEE ON THE AIR FORCE

OF THE

COMMITTEE ON ARMED SERVICES

UNITED STATES SENATE

EIGHTY-FOURTH CONGRESS

SECOND SESSION

AIRPOWER

JUNE 20, 1956

PART XV

Printed for the use of the Committee on Armed Services

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NOTE.—Throughout the text, topic headings have been inserted to facilitate reference. These topic headings are not part of the testimony per se.

STUDY OF AIRPOWER

WEDNESDAY, JUNE 20, 1956

UNITED STATES SENATE,
SUBCOMMITTEE ON THE AIR FORCE,
OF THE COMMITTEE ON ARMED SERVICES,
Washington, D. C.

The subcommittee (consisting of Senators Symington, Jackson, Ervin, Saltonstall, and Duff) met, pursuant to call, at 2 p. m., in room 457, United States Capitol, Senator Stuart Symington (chairman of the subcommittee) presiding.

Present: Senators Symington, Saltonstall, and Duff.

Also present: Fowler Hamilton, general counsel; Ramsay D. Potts, Jr., associate general counsel; Fred B. Rhodes, legal consultant to Senator Saltonstall; Edward C. Welsh, assistant to Senator Symington; and Wallace L. Engle, staff member.

Senator SYMINGTON. Dr. Killian, will you be seated?

Doctor, everybody knows you as a great administrator of scientific activities. You have had a lot of experience in the military field as well as in your other work.

For the record, however, would you identify yourself?

TESTIMONY OF DR. J. R. KILLIAN, JR., PRESIDENT, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Dr. KILLIAN. I'm president of the Massachusetts Institute of Technology, sir. That is my principal occupation. In terms of our activities in Washington, I'm a member of the Science Advisory Committee of ODM. I have been for the last 5 or 6 years a member of the science advisory panel of the Army and was the chairman of that panel up until some time last spring.

Senator SYMINGTON. Incidentally, we saw a briefing here this morning. Unless I was wrong, Dr. Draper of your staff was in the movie. Will you give him my regards?

Dr. KILLIAN. I will, sir.

Senator SYMINGTON. It is the custom to have witnesses before this committee sworn. Will you rise and raise your right hand?

Do you solemnly swear that the information you give to this Subcommittee on the Air Force of the Senate Armed Services Committee will be the truth, the whole truth and nothing but the truth, so help you God?

Dr. KILLIAN. I do.

Senator SYMINGTON. Do you have a prepared statement, Doctor?

Dr. KILLIAN. I do, if I may present it, sir.

Senator SYMINGTON. Will you do that?

Dr. KILLIAN. I have been invited to appear before this committee with the request that I comment upon three aspects of our technological position as it relates to the air power.

First, scientific and engineering manpower; second, organizational and budgetary aspects of research and development bearing upon our military strength; and third, the effect of technological developments upon military organization.

I speak as a private citizen for myself alone, and the views I present do not necessarily coincide with the consolidated views of advisory boards or panels of which I have been or am a member.

I must also make clear that my views are conditioned by my occupation as educator and administrator in the fields of engineering, science, and management.

I am not a military expert nor can I claim any administrative experience which justifies my appearing as an expert on the overall policy or strategy of our military program or its overall budget.

Judgments on details or components of our military program, particularly as they affect planning and budgets, are valid in my point of view only when evaluated by someone whose knowledge encompasses the whole fabric of our military policy and planning and mine does not.

SCIENTIFIC AND ENGINEERING MANPOWER RESOURCES

In discussing first our manpower resources, let me cite at the outset two personal convictions.

First, I am convinced that our national security can be jeopardized, and even lost, by the mismanagement of our resources—both proved and potential—of creative intelligence.

TECHNOLOGICAL RACE WITH SOVIETS

This conviction is made firmer for me by the evidence we have—from the DeWitt study and others—that the Soviets are now educating more scientists and engineers than the United States. They understand, as I understand and this committee understands, that the kind of armaments race in which we are now involved is largely a race in military technology, and that we face economic competition which will be a race in industrial technology.

The strength of our air power cannot be exhaustively examined without examining the Soviet bid for technological leadership and our counter effort.

However, as we seek to build and maintain adequate military strength to survive in this technological contest, we face definite limitations of manpower, material, and money; but—and this is my second conviction—we do not necessarily have comparable limitations on our technological ingenuity if we encourage and apply it wisely.

From the bias of these considered convictions, let me now discuss our manpower resources by first summarizing for you some recent findings and conclusions of a project at the Center for International Studies at MIT which has been seeking, under a grant from the Carnegie Corp., to evaluate the quality of Soviet scientific and engineering education.

Some of this material is presented here publicly for the first time.

Let me then propose several measures, some requiring congressional action, to achieve maximum utilization of our manpower resources. Superior military technology as never before depends upon superior technologists in adequate numbers and properly deployed.

SOVIETS HAVE SURPASSED THE UNITED STATES IN NUMBERS OF SCIENTISTS AND ENGINEERS

From the MIT study, which with your permission I summarize, it is clear that the Russians attach great importance to education in the fields of science and engineering, and it is clear that they recognize the utmost importance of this education to the military power as well as the economic development of their country.

There is do doubt that the Soviets have generated a respect and enthusiasm for science and engineering that has operated to give them a larger supply of trained professionals in these fields, from a smaller total school and university population, than this country's.

SOVIET QUALITY HIGH

What about the quality of this larger supply then?

In many fields it is good; and in the critical scientific areas, first rate.

In making their qualitative assessments of Soviet technical education our MIT researchers used two approaches. They used the direct approach, which provides a measure calibrated in terms of end products: The material goods produced, the professional papers published, and so on. And they used the indirect approach, which employs data that must be calibrated in somewhat narrower and more impressionistic terms. Curriculums, textbooks, teacher-student ratios, and so on.

SOVIETS ADVANCED IN MILITARY TECHNOLOGY

The direct evidence attesting to the quality of the Soviet programs is convincing. The whole world knows, for example, that they have a turbojet engine appreciably more powerful than those in mass production here. And this committee knows in a broader way of the mounting evidence that the Soviets are producing advanced products in many militarily important fields.

I think there is no question that know-how and ideas from German and other sources have helped the Soviets; but, as part of the MIT study states: These ideas—

> would not have been absorbed and put into effective use so rapidly if native groups had not mastered the fundamentals of the problem independently and prepared a sufficient number of engineers to extend and improve borrowed ideas in an original and skillful manner.

QUALITY OF SOVIET EDUCATION AND RESEARCH

The indirect evidence relevant to qualitative judgments is more difficult to assess. But the odds say they're good. Their tests in physics, for example, seem to be excellent; and some of their examinations have impressed MIT faculty members with their rigor.

Of course, we cannot be sure what educational standards are enforced, but it is not without significance that the group of American

physicists who attended the high-energy conference in Moscow last month were impressed with the quality of Soviet research programs in this area.

(Senator Saltonstall entered the hearing room.)

Dr. KILLIAN. The Soviet system, of course, is not all strength; and if it seems a giant to some, it is well to remember that it has at least some toes of clay.

Good as their topmen are, for example, our study found many in the second ranks who seemed inferior to comparable supporting groups here. They apparently have a serious shortage of technicians; that is, the men who service the engineers. Nor do they appear to have a broad technical base comparable in engineering instinct to the American of German base.

Much of their education is narrow and fractionalized. Their engineering education especially seems weaker than ours. It is more limited and, from the point of view of educational doctrine here, much too overspecialized. All these weaknesses may have resulted from their need to push engineers into the industrial stream as quickly as possible.

It also appears that insufficient contact with mature, creative, teaching personnel and a strong emphasis on factual knowledge useful for immediate applications in design and manufacture have limited the number of Soviet young people who give promise of originality and show an interest in research by taking an advanced degree.

But there is evidence that the Soviets are aware of these and other weaknesses and are trying to correct them.

Permit me here some comments on the general pattern of Soviet professional education which will be indicative of some general strengths and weaknesses.

VERTICAL INTEGRATION

To the best of my knowledge, our MIT study, only part of which has yet been published, is the first to emphasize and draw conclusions from the pattern of "vertical integration" which is typical of technical training in Russia.

By vertical integration I mean that, in general, the segments of Soviet professional programs are defined by the industrial monopolies.

That is, the aeronautical industry has its own educational program. This is the opposite of the familiar "horizontal" pattern of subject-matter divisions found in the United States.

In this country, for instance, a man trained as an electrical engineer has a wide range of employment opportunities in many industries.

He may seek a job with a firm manufacturing electric appliances, or with a telephone company to improve the efficiency of communication networks, or with an aircraft builder to design automatic control or radio equipment.

This is the horizontal approach to engineering education. It stresses versatility and fundamentals. It requires institutions which are independent of productive facilities.

In the Soviet Union, as you undoubtedly know, the situation is altogether different. Responsibility for the productive activity of the nation is divided among a small number of powerful ministries, each

of which has full charge of a definite segment of the industrial economy.

Each ministry is responsible for many services and much auxiliary equipment needed in its main task: housing in newly developed areas, factory construction, light and specialized tooling, control equipment, safety equipment.

In particular, each ministry trains in its own institutes the skilled personnel—engineers, economists, and others—necessary for its operations. This is vertical integration. One of its chief weaknesses is its inevitable duplication.

A mechanical engineer of the Soviet Ministry of Aircraft Production, for example, may be trained to design the same valves and piping as one in the Oil Production Ministry without any interchange of information between the two.

Yet the system also permits a flexible use of top technical people within any given ministry. Keymen carry a variety of responsibilities. They lecture at the university, supervise research at the aeronautical institute, serve as consultants to the industry itself.

This multiple-hat system works with apparent effectiveness. The system also permits concentrated and integrated attack on any given problem. It has had its obvious successes.

But, as you might suspect, the system often results in spreading good men too thinly over too many jobs. There is currently a drive to eliminate this multiple-hat system. Certainly it seems reasonable to suppose that it will become less and less necessary as more and more good men are fed through the educational pipelines.

SOVIET EDUCATION IN AERONAUTICS

Finally, let me note for this committee's special interest that one of the major projects in this MIT study was an examination of Soviet education in aeronautics.

This examination was made by Dr. Leon Trilling, a member of our aeronautical engineering faculty. It confirms for this specific field some of the general points I have been making.

The Soviet educational system has trained a small but elite corps of aeronautical scientists who are second to none, says Dr. Trilling.

These top scientists—

he notes—

acting as small, flexible, task forces, have solved a number of theoretical questions * * * selected to keep Soviet aeronautical science abreast of any competitor.

But Dr. Trilling also notes that the Russian technical leaders are perched on a shaky engineering base.

The full cross section of engineers in the Soviet Union—

he says—

have apparently not yet acquired that degree of engineering "feeling" which only broad familiarity with machinery can bring. They work by the book and require detailed direction.

For this reason, excellent designs must frequently be adapted to inferior execution, and tooling or high-grade workmanship is reserved for only key parts of the assembly.

SOVIETS PRODUCING MORE MACHINE TOOLS THAN UNITED STATES

Finally, we all well recognize that the Soviets share the strengths and weaknesses of all autocracies. And while we may find comfort in the weaknesses, in an age of technological contest we cannot afford to overlook their strengths. It is one thing to recite that Soviet automobile production is only between 1 and 2 percent of ours; it is quite another to understand that her production of machine tools now exceeds ours.

SOVIETS DO NOT HAVE TEACHER SHORTAGE

On a limited and selected basis the Soviets can make frontal assaults on any problems they choose. The Soviets can allocate what strength they choose wherever and whenever they choose. They do not have the teacher-shortage bottleneck we do, for example—one reason being that when they need the teachers they allocate them.

Here in this country we need teachers—and especially science and mathematics teachers—desperately. But in our society there is no way we can impress students into programs which would prepare them to be science teachers. We can, however, provide incentives.

What then are some of the specific things the United States can do for the long pull to insure the maximum utilization of our technological manpower resources and to insure a flourishing advancing technology?

SCIENCE MOTIVATION WEAK IN UNITED STATES

Let me say first of all that we need to answer these questions in terms of our own national needs and outlook. We need to concentrate on those qualitative aims which will keep our science and engineering always ahead. We should not let a drive for numbers bring about a reduction in quality.

Since only a third of the top third of our high-school graduates go on to get a college degree, we let lie untapped an unused pool of some 200,000 potential leaders annually.

Even more important in regard to augmenting the quality of our science and technology is the fact that one-third of the top 2 percent of the graduates of our high schools are not going to college.

Some are not motivated; some do not have the means. As one of the major moves to augment the quality of our science and other professional work we must provide the motivation and the means for more of this missing third to get a college education. We must also make special provisions for gifted young people so that they are not held back by a lockstep system of education.

RECOMMENDS COMPETITIVE SCHOLARSHIPS, PRIVATE AND FEDERAL GOVERNMENT

I have advocated that we start now by establishing about 9,000 competitive, annually awarded, 4 year scholarships for undergraduate study. If industry and private funds will support such a scholarship program, well and good. If not, the Congress in my judgment should establish Federal scholarships. These scholarships might be of three kinds:

1. Three thousand scholarships earmarked for those of high ability who wish to study science and engineering:
2. Three thousand for high-ability high-school graduates without designating in advance a field of study;
3. This is the most important category; 3,000 to be awarded to students who have taken enough advanced work in high school to have mastered there such freshman college subjects as calculus, physics, and English, in addition to meeting other high-school graduation and college-entrance requirements. The need for this kind of scholarship to give recipients advanced standing in college was recently proposed in a discussion of the Science Advisory Committee of the Office of Defense Mobilization.

This last class of scholarship would dramatically highlight the need for a lifting of sights in our high schools and for more adequate opportunities and rewards for gifted students.

It would help to encourage better and more advanced teaching of science in high schools. It would enable students of ability to cover more ground in college. Such a program would be a powerful incentive to realize the White House Conference recommendation that the next great advance in our public-school system should be "improved provision for talented young people."

To continue to educate potential scientists and engineers, as well as an American people who are alert to their responsibilities in society and competent for their tasks, the schools must have greater support in their attempts to cope with the enormously larger new generation of students.

SHOULD DOUBLE NATIONAL EXPENDITURES FOR EDUCATION

A basically essential move is to double our national expenditures for education, as recommended by the committee for the White House Conerence on Education in the years ahead.

This will require increased help from all sources: private, Federal, State, and community.

CONGRESSIONAL ACTION URGENTLY NEEDED

Critically important now is action by Congress on the recommendation before it that Federal funds be appropriated for emergency school-building needs. It will not be in the national interest to allow regional considerations to prevent this action; we should not temporize in meeting our educational crises. In an age of supersonic flight we cannot rely on a horse-drawn educational system.

One of the critical weaknesses in our precollege schools is a diminished interest in mathematics and science. There are not enough courses and not enough teachers and not enough inspiring teachers and not enough rewards for inspiring teachers.

BECOMING A NATION OF MATHEMATICAL ILLITERATES

Recent studies have shown that we have come perilously close to becoming a nation of mathematical illiterates in a period when mathematics is an essential ingredient of airpower.

In the interest of airpower, if nothing else; in the interest of maintaining a strong competitive military and industrial position vis-a-vis

the Soviets; in the interest of the national welfare, we must move boldly to correct these educational deficiencies.

I like the boldness of the idea recently proposed to the joint congressional Committee on Atomic Energy by Prof. I. I. Rabi, the Nobel-prize physicist. Let Congress provide a $500 scholarship to any young person who passes with satisfactory marks an examination covering a 4-year secondary-school program in mathematics. Let this scholarship be renewed if in college he demonstrates proficiency in calculus or some higher mathematics subject.

To improve our teaching of science, I like the plan proposed by my associate professor, Jerrold Zacharias, of MIT. Let a group of the best physicists in the country come together in a special study group—the kind of study-group technique that has produced some of our most important advances in military technology—to plan a whole new approach to elementary physics education.

Let them set the new goals demanded by modern physics, design new courses, visualize fresh experiments and imaginative demonstrations.

Let these plans be reduced to reality by a sort of working group which will design and direct the making of, say, 90 professionally executed films each with the necessary accompanying manuals and texts.

A $1 million to $2 million project of this kind can infuse new life and great teaching art into thousands of our public schools.

These recommendations for strengthening and tuning up our educational system arise out of the conviction that we must be as bold, imaginative, and alert in augmenting our educational readiness and strength as we are in insuring our military readiness and strength.

Next in my list of requirements for insuring a flourishing technology is the importance of not permitting short-term objectives to dry up our emphasis on long-term strength.

IMPORTANCE OF BASIC RESEARCH

For example, we need a better balance between basic research and development, between fundamental ideas and hardware, and we are making only slow headway in achieving this better balance.

Even though the President, the Hoover Commission, the Riehlman committee, and other influential voices have emphasized the need for basic research, only about 7 percent of the Government's research and development funds are allocated to basic research.

Senator SYMINGTON. You said, "even though the President, the Hoover Commission," and there was one other that is not in this script.

Dr. KILLIAN. Yes; the Riehlman committee, which is a subcommittee of the Committee on Internal Investigation, 2 years ago made a report on research and development. The report was entitled, "Organization and Administration of the Military Research and Development Program," this intermediate report of the Committee on Government Operations. They have a specific recommendation that we should give more emphasis to basic research.

AIRCRAFT INDUSTRY'S EXPENDITURES FOR BASIC RESEARCH SMALL

According to a recent National Science Foundation study, only 2.4 percent of the total research and development expenditures of the

aircraft industry go for basic research, compared to 4 percent for all industry and 10.5 percent for the chemical industry. Along with the electrical equipment industry, the aircraft industry—as this committee knows—far exceeds all other industrial groups in the total expended for research and development.

It nevertheless spends for basic research a smaller percentage of its total research and development budget than the average percentage for all industries.

I respectively suggest that in an industry so dependent upon innovation and sophisticated technology and so receptive to new ideas, this imbalance should be a temporary one.

I suggest, further, that procurement contracts with the aircraft industry under appropriate circumstances make provision for supporting research to enable the industry to do a better production job.

Senator SALTONSTALL. Dr. Killian, do you draw a distinction between basic research and pure research?

Dr. KILLIAN. No, I do not. When I speak of basic research I mean in effect pure research. This is a very difficult sort of thing to define. You never know when you stop having basic research and get into applied, but I'm talking about the kind of research that in general is directed toward new concepts, new principles, rather than producing a piece of hardware.

It is the yet unanticipated, unconceived discoveries which may determine our military strength tomorrow, and we must provide the environment from which such discoveries are most likely to come. If there are to be yet unimagined weapons affecting the balance of military power tomorrow, we want to have the men and the means to imagine them first. This may not depend upon the size of our military defense budget, however large.

Russians are strongly motivated to expand their basic research and to be top flight in it. As one of our scientists who recently visited Russia has observed, the Soviets have a great drive and determination, as a matter of national pride, to be champions in basic science as well as in other fields—apparently including athletics.

PLAN NEEDED

I come finally to the suggestion that we need also carefully to formulate a broadly conceived strategy for maintaining the United States' technological supremacy.

This committee well knows the great influence exerted by the Air Policy Commission in its notable report in 1948 entitled "Survival in the Air Age."

We need a comparably thorough, objective, nonpolitical study to chart our technological progress in the years ahead and to elucidate the effects of technological change on management and organization, especially in Government.

Such a study could deal with such matters as the following:

(1) An appraisal of the utilization of scientific and engineering manpower in the United States—in Government, industry, and elsewhere—for the purpose of suggesting more efficient use and conservation of this manpower. In my judgment, one of our acute problems in the United States at the present time is how we bring to bear

the best available scientific and engineering talent on the most important problems.

Again, one of the strengths of the Russian system is that they are able to put their best men on their toughest and most important problems. In our less regimented system this is harder to accomplish, but I am by no means sure that we are proceeding as effectively as we might in using our best brains on the most important research and development. I would include as one of the top-priority areas here basic research.

(2) Another hard look at our research and development activities in the United States to see if there may be neglected areas important to our air power and defense. Are we devoting enough effort to the array of sciences and technologies essential for steady progress in propulsion—the development of new engines and new fuels?

Are we giving enough attention to a more fundamental approach to the design of new and better materials?

Are we providing adequate resources for geophysics research, especially as it relates to our understanding of the physics of the upper atmosphere and thus to weather forecasting and possibly to weather modification?

Are we doing enough research in hypersonic and extra-atmosphere flight? I speak here not of hardware development but of the supporting, underlying research important to advance in these fields.

(3) A study of ways whereby we can move more rapidly from discoveries in basic science to engineering applications and to production, should be a part of this study. This is one area where I feel that we need improvement most.

And the evidence would indicate that the Soviets at the present time, through their monolithic organization, are able to move more rapidly from the basic idea to a piece of hardware than we. Some informed estimates indicate that in the production of new airplanes, for example, they are able to save 1 to 3 years over us because of their directness of action and rapidity of decision.

(4) A careful study of the strengths and weaknesses of our system of research and development and production as compared to the Soviets'.

(5) A careful study of the impact of weapons systems on military organization (a subject I discuss in more detail later on).

These are but a few of the many questions which could be fruitfully examined in a study devoted to "Survival in the Age of Technological Contest." I close my discussion of manpower resources by urging again that such a study be undertaken.

Let me turn next to the second array of activities you have asked me to discuss—the management and budgeting of our military research and development program. Here my comments are those of a bystander and therefore are of less value than my preceding remarks. In part they do reflect views widely held in the civilian scientific community.

ORGANIZATIONAL ACCOMPLISHMENTS OF FEDERAL GOVERNMENT

Let me first recall the impressive list of organizational accomplishments in the defense area since World War II. By establishing and brilliantly managing the Office of Naval Research, our Navy Department has given a sustained demonstration of how Government can

wisely support basic research for military strength, how to create the right conditions to get it done, and how the military can work productively with civilian scientists. By giving the AEC the right form at the start, Congress achieved with this agency a management breakthrough in research and development.

Its policy of contracting out its research and development activities and its success in getting first-rate personnel has tapped the basic American resource of enterprise.

Next, the Air Force, not without difficulty, created its Research and Development Command, a new, integrated form of military organization for research, which separated research and procurement, always poor bedfellows. It also established and carefully cultivated its Scientific Advisory Board, the most effective civilian scientific advisory group yet assembled by the military services.

The authorization of an Assistant Secretary of Defense for Research and Development and the effective development of this office, and the growing use of the Science Advisory Committee of ODM by the Office of the President have been major advances in the better use of our scientific resources.

Two years ago an able subcommittee of the Committee on Government Operations of the Congress achieved a notable report and this, Senator Symington, is the one I spoke of before, on the management of military research and on the subtle factors of motivation and environment so important in scientific activities.

Significant, too, was the action of the Senate Military Affairs Committee in engaging a technologically competent consultant to make for it an exhaustive study of the policy and weapons system for continental defense.

These examples demonstrate our growing national wisdom in promoting scientific and technological advance. At this juncture our need is to build upon these achievements, recognizing that our management tasks become more complex as our technology grows more complicated, our need for advanced planning and taut readiness greater, and our competition more competent and determined.

NEEDS IN RESEARCH AND DEVELOPMENT MANAGEMENT

What further do we need to do? In my judgment our most immediate needs fall into two categories:

(1) We need to strengthen the coordination of scientific activities at policymaking levels and thus increase the probability that more strength and skill in coordination and planning at the top will bring about more effective research and development all down the line. The impact of science and engineering on key policymaking calls for competent policy advice by scientists and engineers.

(2) We need to invent new ways for budgeting research and development that achieve a reasonable compromise between necessary fiscal prudence and the requirements for good research which call for maximum freedom, a willingness to fail, and a long view.

Let me suggest some specific moves to accomplish these ends:

ASSISTANT SECRETARIES FOR R. & D.

I first urge the importance of Congress acting favorably on the proposal presently before it to authorize Assistant Secretaries for Research and Development for each of the military services.

This was recommended by the Hoover Commission.

The Air Force already has the authorization for such an Assistant Secretary. I am in hearty accord with the other recommendations of the Task Force Subcommittee on Research and Development of the Hoover Commission, which recommended Assistant Secretaries, that there be a Council made up of these Secretaries, of which the Assistant Secretary of Defense for Research and Development would be the Chairman.

This Council of Assistant Secretaries for Research and Development could be an extremely important group for the strategical planning of our overall research and development program.

The individual secretaryships should be filled by men with experience in technical administration, especially that kind of technical administration which has to do with innovation and advanced technology. In such posts you really need professionals, for the whole effect would be lost if men were appointed to such posts for reasons other than their professional competence.

Scientists and technical administrators must be willing to take these posts. The responsibility of these Assistant Secretaries should include the management of each of the services' research and development program, the maintenance of its relationships with the scientific community, and the cultivation of a vigorous program for technological innovation and advance.

I further urge that each of these Assistant Secretaries be allotted an adequate staff of scientists and engineers.

These staffs need not be large. I think it is of the utmost importance that the Assistant Secretaries not be left without adequate staff work or staff backing.

If we could bring about these appointments, fill them wisely, and create the effective coordinating Council recommended by the Hoover Commission, we would have a powerful mechanism for the planned, coordinated advancement of our weapons technology.

WEAPONS SYSTEM EVALUATION GROUP

The recent move of the Department of Defense in inviting a group of educational institutions to undertake, through a nonprofit corporation, the management of the weapons systems evaluation group is of very great importance.

It has never been possible before to bring this evaluating and analytical group up to strength within the Department of Defense, but I feel confident that the new organization, analogous as it is in many respects to the Rand Corp. and to Associated Universities, Inc., will be able to achieve this objective.

WSEG can be of very great assistance to the Joint Chiefs. It should also be helpful to the Assistant Secretary for Research and Development and, through him, to the Secretary of Defense.

This effort needs all possible encouragement by the Congress and by the scientific community.

NEED TO COORDINATE WITH CIVILIAN SCIENTIFIC COMMUNITY

Next, it is of very great importance that we have a research and development organization that can strike deep roots into our civilian scientific community and can tap our most basic and advanced research so that we are making available to military research and development with great rapidity the new developments which may be profoundly influential in new weapons technology.

As the Hoover Commission Report on Research and Development commented, the military services "have not distinguished themselves in the initiation of radically new approaches to weapons systems."

There are striking exceptions to this, but it could hardly be expected that the really radical approaches would come from within the services.

They must originate in the creative basic research that takes place in the universities and other institutions where the fundamental new ideas are most likely to be generated.

Next, I see great advantage in the continued use, as needed, of engineering and scientific advice and appraisal by the National Security Council on defense matters where science plays a formative role.

The Science Advisory Committee of the Office of Defense Mobilization has been effectively used at this level.

URGES FLEXIBILITY IN FISCAL MANAGEMENT

Next, I stress the importance of flexible fiscal management of research and development. The R. and D. budget should be predicated on an overall grand strategy for weapons development but which includes as an inherent concept the recognition that the strategy must be modified as new technological opportunities arise. We have made great progress in meeting this need over the last decade but our changing military needs require the introduction of still further flexibility.

I think I should go so far as to say that the fundamental requirement for a sound budgetary policy for R. and D. is the maintenance of flexibility to encourage further innovation, to pick up the new and bright ideas as they come along, to create a climate where men in the R. and D. establishments will not be reluctant, discouraged, or unreceptive when they see new ideas and new projects that need help and sponsorship.

The achievement of this kind of flexibility and willingness to try the new is dependent upon a number of management policies, including the following:

(*a*) With R. and D. coordination and planning at the top there should be a firm procedure for favoring important projects and cutting back or dropping outmoded or low-priority projects. This is one of the hardest of all things to do in the field of research management, not only in Government and here I speak feelingly, but then in educational institutions and in industry.

The secret, here, I suggest, is to make so clear the importance of the top priority projects that low priority ones lose their attractiveness. The smart men want to be associated with the projects of greatest significance and challenge.

Too rigid and too centralized budget control can work against this kind of adjustment. Fiscal judgment tends to take over where a

far more economical result could be obtained by permitting sound scientific judgment to operate freely in stressing the important at the expense of the unimportant.

If the R. and D. budget could be so managed as to make it easy to give financial support to new ideas as they develop, then the good people could move easily to the good projects and the financial managers would have the best of all criteria to help decide which projects can be curtailed with financial savings.

They would only have to look around to see which are attracting the good technical people to know which are the good technical bets.

I do feel there is room to economize on manpower and money by relentlessly excising those development activities devoted to unnecessary refinements of materiel.

DISCRETIONARY ALLOTMENT OF R. AND D. FUNDS

(*b*) There should be increased opportunities for discretionary allotment of funds at the working R. and D. level, so that the people who are at the grassroots and can see new blossoms emerging can encourage them at the right time.

MILITARY R. AND D. BUDGET SHOULD INCREASE

(*c*) Even though satisfactory progress is being made in dropping or curtailing the low-priority projects and getting rid of overrefinements, I think it still likely that our total military R. and D. budget should grow larger.

As our R. and D. program has grown, its fixed costs have increased. We have added huge development undertakings such as intercontinental ballistic missiles. We have the stern requirement to be in a constant state of military readiness. We have a rapidly advancing technology facing us, with new imperatives for weapons development.

All of this means a greater effort, and I do not see how in the years ahead it can be contained within a fixed R. and D. budget and still leave funds available for the absolutely essential venture capital to support basic research and try new ideas.

In some fields manpower limitations do limit augmenting R. and D., but not in all. We can still do much to back up our outstanding research leaders and teams.

OPPORTUNITY TO SUCCEED AND TO FAIL ESSENTIAL IN RESEARCH

(*d*) We should recognize the special nature of research and its effect on contracts and fiscal controls. Fiscal officers are generally on the spot, expected to defend every phrase and clause and expenditure. We must recognize that people who buy and do R. and D. are bound to make mistakes and go down some blind alleys.

Some ideas and projects will not pay off. This is inherent in research. The contracting officers and the researchers should not be pilloried when they have failures. We can afford for them to have a lot of failures if they succeed in bringing about the big jumps. In research it is dangerous to be made afraid to fail.

Contractual procedures designed for procurement are hardly ever appropriate for research, and short-term budgets are frequently inadequate for effective research.

LONG-TERM R. AND D. COMMITMENTS

I feel, for example, the Congress can help to make it easier for the Department of Defense to make long-term commitments for research and development.

There is a natural tendency in all large organizations (by no means confined to government) for fiscal controls and philosophy to encroach gradually upon the essential freedom of action of research personnel, and this is a process that must be constantly watched and resisted.

SOVIET RESEARCH LESS CONTROLLED BY FISCAL LIMITATIONS

One of the important pieces of information that comes to us about Russian progress at the present time is that they apparently have given great freedom, indeed blank checks, to their scientists and engineers in important areas to proceed without fiscal limitations.

All of this is by way of answering your question:

QUESTION OF ADEQUACY OF R. AND D. BUDGETS

Is our present level of R. and D. expenditures right, and are our budgetary controls helping or hindering our military effort?

I can only answer this question by emphasizing the above more fundamental considerations which I believe must govern R. and D. policies in the months and years ahead.

I think it is fruitless to discuss whether a given budgetary total is the right total or not unless we are sure that we have the right strategy for R. and D and that we have an organizational mechanism which partakes of the characteristics I have outlined—that provides the judgment, the foresight, and the coordination that can plan ahead, than can provide the administration and the Congress with adequate information on priorities and the quality and up-to-dateness of our research and development program.

I am equally sure that we have come a long way in the management of R. and D., but that, in the period of explosive technological change we are now in, it does not require criticizing past or present policies to say that changes and refinements must be made to meet new conditions.

EFFECT OF ADVANCING TECHNOLOGY ON ORGANIZATION

I come finally to a very crucial matter—the effect of advancing technology on organization. I am sure that this committee has been overwhelmed with evidence of the impact of technology upon weapons and upon the integration of these weapons into our military structure, but I cannot stress too strongly the fact that increasing attention needs to be given to the organizational implications of complex systems-engineering concepts. These systems-engineering concepts are affecting the organization of industry and will do so to a far greater extent in the future, but the problem before us is the fact that weapons partaking of these great engineering-systems concepts require careful integration of components if they are to be really effectively used.

This integration breaks across many departmental lines, both in the fields of research and development and in military operation and management.

MILITARY TASK NO LONGER DIVIDES INTO THREE CLEAR-CUT AREAS

One thing is abundantly clear. The military task no longer divides up neatly into three mission areas, defined by the vehicle the fighting man rides in.

A striking example of the organizational requirements of the weapons system is to be found in our modern air defense, where it has been necessary to design a great integrated system and to organize a theater-type command (which needs still further integration) to manage this mechanism for all of the North American Continent.

The defense against the manifold nature of the threat of air attack requires a defense that must have eyes and ears, a central nervous system, a quick-acting brain, and a fighting response when necessary. This cannot be broken down by services; instead, all three services must take part and their activities must be carefully integrated.

In a larger sense, weapons-systems technology has made possible global offenses, and global offenses require global defenses.

There are no longer any natural boundaries which cannot be penetrated by comprehensive offense, and our defense against this comprehensive threat does not separate naturally into three parts but requires new, functional-type military organizations to do the job.

One of the most urgent needs in our whole defense organization is for men, whether they be in uniform or out, who understand the integration of systems and the organizational implications inherent in our new-weapons technology.

So far there are all too few men who have the capacity to visualize and direct the integration of complicated technological systems.

INTEGRATION ESSENTIAL IN MILITARY ESTABLISHMENT

One of the great responsibilities is to train this new breed of engineer. In my judgment, one of the major problems affecting the security of the United States is our capacity to deal wisely with this problem of integration within the Military Establishment.

I do not suggest that this means complete unification of the three services.

I do suggest that in dealing with air defense, with intercontinental ballistic missiles, and other great weapons systems we must create the organizational patterns which will make it possible, first, effectively to develop them without wastage of manpower and resources and unprofitable duplication of effort, and, secondly, to manage them in terms of their wholeness as systems.

ORGANIZATION HAS NOT KEPT UP WITH TECHNOLOGY

So far we have not been able, in the definition of the roles and missions of the services, to keep pace with evolving weapons-systems technology and as a consequence we lengthen our lead time, we make more difficult our decision-making processes, we needlessly increase costs, and we find it difficult to avoid friction and duplication of effort.

I do not minimize the difficulty of achieving this greater degree of integration, and I speak of its importance not to criticize existing practices but to urge a growing recognition of the fact that a revolution is upon us as a result of technological advance and that the inevi-

table logic of present-day weapons technology, as well as nonmilitary technology, is to force new patterns of organization affecting traditional departmental boundaries and even political concepts.

I cannot escape the feeling that events of the technological age are moving faster than our perception of their meaning, either in industry or government, and that we need more carefully to tune in our receivers to pick up the changes which lie ahead.

MAXIMUM DEGREE OF READINESS ESSENTIAL

I conclude with the mention of one factor which to my mind today is of overriding importance; that is, to do those things now within our grasp and means to achieve a maximum degree of readiness.

This is as of today more important in my judgment than any discussion of budgets or number of bomber wings or trying to match or exceed Soviet plane production or R. and D. policies.

Are we deploying what we have and can get in the immediate months ahead to give maximum deterrence and to insure maximum protection of our striking power?

MILITARY STRENGTH MEANS MORE THAN ADDITIONAL AIRCRAFT

Simply adding more and more planes does not necessarily give us optimum strength. Of first priority is a balanced integrated combination of offensive-defensive power designed to meet our military requirements and not to duplicate that of the Russians.

In saying this I stress the importance of the imponderables in comparing our own present strength and future potential with that of Russia. National strength cannot be measured in quantitative terms, or comparative strength expressed by net evaluations. We must recognize the possibility of an intellectual surge in Russia arising out of deep motivations of a nonmilitary sort.

CREATIVE ATMOSPHERE NEEDS FOSTERING

In the United States we must give great importance to all those subtle factors of motivation, character, and enterprise which give our society coherence and excellence.

We must be concerned not only about military strength but about maintaining those conditions and goals which release the maximum energies and the most creative, constructive thought and action of our people.

This deeply felt conviction has colored all my observations in this statement.

APPRECIATION

I thank you very much, sir.

Senator SYMINGTON. Thank you very much, Doctor. I am sure we all agree that was a magnificent presentation. Before turning to counsel, I make this observation.

The sentence you have on page 24—

So far we have not been able in the definition of the roles and missions of the services, to keep pace with evolving weapons systems technologies and as a consequence we lengthen our lead time, we make more difficult our decision-making processes, we needlessly increase costs, and we find it difficult to avoid friction and duplication of effort.

If we can just get that thought, expressed in those words, over to the people, I think these hearings have been worthwhile.

Field Marshal Montgomery said recently that if we don't stop building the defenses of the free world on the basis of tradition, and start building them on the basis of progress, the free world is going broke.

Inasmuch as 65 cents of our tax dollar now goes for current military defense, it is obvious a little saving in this field of current Government cost would net more than a far larger percentage saving in any other field.

Yours is a fine paper. It closes one of the gaps in the effort for facts this committee has been trying to obtain.

Mr. Counsel, will you proceed.

Mr. HAMILTON. Thank you, Mr. Chairman.

Dr. Killian, if, in the course of any of the interrogation by the committee or by me, answers are called for that involve classified material, I wish you would feel perfectly free to say, if you care to do so, that you would like to defer that answer for executive session. I do not anticipate, in view of the character of your statement, that questions of that kind will arise, because as I understand it from our talks before the hearing, before you came on as a witness, you are not now presently engaged in the Government on the details of either the administration or the performance of any particular research and development projects for any of the armed services. Is that correct, sir?

Dr. KILLIAN. That is correct.

Mr. HAMILTON. So that the knowledge you have is the kind of knowledge that is covered by the statement and not detailed knowledge with respect to administration or fiscal matters relating to any particular project.

Dr. KILLIAN. I have never looked at the Defense Department budget in any detail, so I really know nothing about that.

Mr. HAMILTON. Thank you, sir.

KILLIAN REPORT

Dr. Killian, you were chairman, were you not, of a committee that had a rather broad look at research and development questions and made a report?

Dr. KILLIAN. Yes, this was the panel that was set up at the request of the President by the Science Advisory Committee on ODM.

Mr. HAMILTON. When was that panel established, approximately, sir?

Mr. KILLIAN. It was established about a year and a half ago; made a report around last February or March, a year ago.

Mr. HAMILTON. Did you have as chairman of that panel any responsibilities for seeing to it that any of the measures were taken?

Dr. KILLIAN. None whatever. This was a group of consultants who made a report and then withdrew.

Mr. HAMILTON. Once the report was made your responsibility was over, is that correct?

Dr. KILLIAN. Yes.

Mr. HAMILTON. I think, Mr. Chairman, that is all I have.

Senator SYMINGTON. Senator Saltonstall?

Senator SALTONSTALL. Dr. Killian, it is good to see you here.

Dr. KILLIAN. Thank you, sir.

Senator SALTONSTALL. And we welcome you as the president of one of our fine Massachusetts institutions.

STATING THE PROBLEM

Do I sum up your statement when I say this?

What you urge is that we train more engineers, outline for them the problems, and then give them the go-ahead sign under proper organization at the top so as not to waste time, energy, or money.

Then we should advance our military organization to handle these new weapons as they come out of this basic research and technological development.

Dr. KILLIAN. That is one way of stating the objective. I would supplement that by saying that I think we are in a period, as I said, of revolution when things are happening so fast that we have a real problem to adjust ourselves, particularly our organization to meet new conditions, and I think some of these things that I have said are most important in getting quality, in getting coordination, in getting the right people in the right places, by a system of education, incentive, and not by regimentation.

Senator SALTONSTALL. You have really answered my second question: Can we do what you urge under our free system of life here in America?

Dr. KILLIAN. I feel very much that we can, by following our own incentive system rather than by following any foreign system of regimentation. I have been constantly impressed by the fact that if you let, for example, the scientific community know where the important problems are, you can usually get them to concentrate on those problems.

Senator SALTONSTALL. In other words, give a well-educated man a brandnew problem, let him go ahead, and he will come up with results.

Dr. KILLIAN. Well, if he is educated in the right field.

Senator SALTONSTALL. I recall some of the things you mentioned.

Dr. KILLIAN. Yes.

Senator SALTONSTALL. Of course, the National Science Foundation has scholarships now.

NEED SCHOLARSHIPS AT PRE-GRADUATE LEVELS

Dr. KILLIAN. At the graduate level.

Senator SALTONSTALL. I didn't hear that.

Dr. KILLIAN. I did say they have fellowships at the graduate level as I understand it.

Senator SALTONSTALL. You mean they ought to be at a lower level?

Dr. KILLIAN. I think we need scholarships at the lower level to get the bright boys, the gifted boys, into our colleges—those who have financial need, those who have adequate competence, so we don't waste talent. Once they get into the college I think we can find ways of taking care of them.

Senator SALTONSTALL. Do you think the National Science Foundation is helping them?

Dr. KILLIAN. Very definitely, but at the graduate level.

QUESTION OF MORE ASSISTANT SECRETARIES

Senator SALTONSTALL. Now may I turn to two things concerning the organization of our Government today? You mentioned these Assistant Secretaries for Research, as were suggested by Mr. Hoover, and an Assistant Secretary of Defense to guide their policy. That organization has now been set up; has it not?

Dr. KILLIAN. I am unaware if Congress has acted on authorization for Assistant Secretaries in the Army and the Navy.

Senator SYMINGTON. Will the Senator yield?

Senator SALTONSTALL. Yes.

Senator SYMINGTON. I believe if the Congress does not act on it, it automatically becomes law.

Dr. KILLIAN. Does it?

Senator SYMINGTON. I am not sure.

Senator SALTONSTALL. The chairman is right.

Dr. KILLIAN. But I think that those authorizations do not now legally exist.

Senator SYMINGTON. That is correct. I think a certain period of time has to elapse.

LONG-TERM APPROPRIATIONS NEEDED FOR RESEARCH

Senator SALTONSTALL. Now also you mentioned long-term budget. While no Congress can appropriate or commit another Congress under our Constitution, we do have these long lead times, for instance in the building of a battleship, or an aircraft carrier, or these modern airplanes.

Dr. KILLIAN. Right.

Senator SALTONSTALL. In the same way, as I understand it, we have appropriated money in recent years for basic research and for development and procurement of prototypes. That has not been handicapped, has it, by appropriations being blocked in the Congress, that you know of?

Dr. KILLIAN. I can't answer this in detail. I know there are some limitations on making long-term commitments, I do know that the Congress authorized the Office of Naval Research to make commitments up to 5 years, I believe, on research and development contracts.

So far as I know, this is the only specific authorization of this kind. It is also true, as you suggest, that Congress makes funds available that can be expended in any successive year. I think the real problem is to set up a program that, say, will require 5 years to give the people who are responsible for that program reasonable assurance that there will be backing over that whole period.

This may require appropriating all that money at once if it is available in the budget, or it may say that we intend as a matter of principle to support this year in and year out. I don't know what the legal details are of doing this, but I am stating the specifics, the requirement.

MILITARY GOAL

Senator SALTONSTALL. If I might ask a final question, our goal is, as you say on page 25, a bold, integrated combination of offensive-defensive power designed to meet our military requirements and not to duplicate that of the Russians.

Dr. KILLIAN. Yes, I think so.

Senator SALTONSTALL. That is the goal in a military way; a buildup of engineers, scientists, organizations, and so forth.

Dr. KILLIAN. Right.

SOVIETS OUTPRODUCING UNITED STATES IN MACHINE TOOLS

Senator SALTONSTALL. Mr. Chairman, I think that is all. I was interested in one other thing you said which is important, although perhaps not of primary importance to this hearing. You said the Russians have more machine tools than we have.

Dr. KILLIAN. So I have been told.

Senator SALTONSTALL. You what?

Dr. KILLIAN. I have been told that this is true, that they are producing more machine tools than we have. That is a different thing from saying that they have more.

Senator SALTONSTALL. One of our difficulties with the machine-tool industry in Massachusetts is perhaps we are not giving our people enough chance to buy new machine tools. I have no further questions. Thank you, Mr. Chairman.

Senator SYMINGTON. For some time it has been a mystery to me why this Government goes along with the policy of letting our allies sell machine tools to Russia, but at the same time won't let our own manufacturers sell any to Russia.

If they are building more over there than we, perhaps they wouldn't consider it necessary to buy in quantity from us. I remember in recent hearings before the Government Operations Committee it was stated the Communists would buy a few of our latest models, copy those, and then go ahead with their own production.

Senator Duff?

EDUCATIONAL AIDS REQUIRED

Senator DUFF. Dr. Killian, am I correct in assuming that one of your basic concepts is that we must make available the capabilities of the large number of our youth who currently are not receiving a technical education?

Dr. KILLIAN. Yes; I would say receiving an education. We don't want to divert all of our able people into science and engineering alone. I think this would be wrong.

Senator DUFF. But as things stand today, we are losing a great number of our very fine potential contributors by not giving them a college education.

Dr. KILLIAN. Yes; I think so.

Senator DUFF. And that is going to require help by the Federal Government to education in order to enable local school districts to expend money for schools and to bear that part of the expense which they can't bear, and also to provide them proper training.

Dr. KILLIAN. I would only go so far at the present time to say that I think that the Federal Government needs to help in the school-building program.

Senator DUFF. That is what I tried to say, whether I made it clear or not.

Dr. KILLIAN. Yes. I don't think we clearly see yet how far we ought to go in providing Federal aid for secondary-school education,

public-school education, except this kind of thing which is an emergency at the present time.

I would also go further and say that unless we can muster enough private funds too for the kind of scholarship program that I propose, I think the Federal Government ought to do it.

Senator DUFF. Thank you, sir.

Senator SYMINGTON. Doctor, let me ask you a few questions based on the first 8 pages of your fine statement.

SOVIETS EDUCATING MORE SCIENTISTS AND ENGINEERS THAN UNITED STATES

You say that according to the evidence the Soviets are now educating more scientists and engineers than the United States; and that has been confirmed to the Senate Armed Services Committee in previous hearings.

Dr. KILLIAN. Yes.

Senator SYMINGTON. The figures were rather startling. As I remember, in 1950 we were putting out some 50,000 engineers and scientists to their 20,000. In 4 years those figures were in effect reversed. We had one large manufacturer who testified his company, one of the large electrical companies, needed 3,000 engineers in June. They wanted 3,000 engineering graduates. They got 600. To the direct question as to whether or not that held up the defense work in his company, he replied, "Of course."

That condition can only get progressively worse unless we make some material alterations in our planning. Is that a fair statement?

Dr. KILLIAN. Yes; I think that there is evidence of improvement in this situation because the great publicity that has been given to this problem, the incentives that are becoming recognized as available particularly in the form of increased salaries and so on are attracting increased numbers of youngsters into scientific and engineering programs, but not yet enough.

Senator SYMINGTON. I have seen a lot of publicity about it. Like Mark Twain and the weather, everybody talks about it but little is done. Would you give us some illustration of some of the things that have been done?

SHORTAGE PUBLICIZED

Dr. KILLIAN. Yes, first of all, the fact that there has been a nationa campaign to publicize the shortage I think has been the most important thing. There have been all kinds of grassroots activities that have resulted in that regard. I was down in Texas some time ago making a talk about this kind of thing, and a young woman came up to me afterward and said she was a member of the Junior League in Dallas and that they had just organized the Texas Teachers Association.

The purpose of this association was to get science teachers for the Texas high schools. This kind of grassroots activity is going on all across this country, and the enormous resilience of our country once we get the public to know what our problem is I think can produce results, so I am encouraged.

The other factor is that the enrollment in our engineering and scientific institutions is going up.

The applications for admission are going up, have been for the last 2 years. We have reversed the trend.

Senator SYMINGTON. Is that in the percentage of total applications or because of an increase in the number of youths and women available?

Dr. KILLIAN. I think it is going up out of proportion to the population increase.

Senator SYMINGTON. In percentage.

Dr. KILLIAN. Yes, but still not enough I must say. I don't think we are going to have enough capacity in the immediate years ahead to train all that we need.

SOME IMPROVEMENT SEEN

Senator SYMINGTON. Have you any figures you could give us in support? Do you know of any figures? If it is true that in 1954, as testimony said, we were graduating 20,000 engineers and scientists against their 50,000, have you any figures that show that has been improved in 1955?

Dr. KILLIAN. In 1956 I think our total output was substantially greater than 20,000.

Senator SYMINGTON. Would you know roughly what that was?

Dr. KILLIAN. I believe it is of the order of 27,000.

Senator SYMINGTON. 27,000?

Dr. KILLIAN. This is off the cuff but I think this is right.

Senator SYMINGTON. We understand it is strictly a "guestimate."

DEMAND CONTINUING TO RISE

Dr. KILLIAN. Right, and I think it will be up again next June, and up the following June, too. We already are having employers come looking for men who are going to be graduated a year from now. This last June we had 800 companies come to the campus to try to employ 700 men.

Senator SYMINGTON. 800 companies trying to employ 700 men.

Dr. KILLIAN. That's right; and some of them wanted 20 and 30 men apiece, so the pressure was just tremendous.

Senator SYMINGTON. We go from 20,000 engineering graduates in 1954 to 27,000 in 1956. Based on our knowledge of the attention Russia is paying to this problem, do we know where they went from 1954 to 1956?

Dr. KILLIAN. No; I do not know the answer to that.

Senator SYMINGTON. I ask that because we have had no comparable hearings this year as last year. So we have no figure either.

NUMBERS AND QUALITY NEEDED

Dr. KILLIAN. That's right, but I would add one footnote to this, Senator. We ought not to get involved in a numbers race pure and simple.

We need more men, but we need more good men more than we need more men. Our whole problem is to get the kind of engineer that can give us the advances that we ought to have, and not to get into an academic numbers race with the Russians.

Senator SYMINGTON. I don't believe in getting in any numbers race unless it is when your own number comes in. Then it is always pleasant.

Dr. KILLIAN. That's right. Of course a larger pool means more and more good men in the pool.

ARE WE GOING TO COMPETE WITH SOVIETS ON ANY BASIS?

Senator SYMINGTON. Speaking of numbers, we decided years ago we weren't going to compete in numbers in our Army. Then later on we decided we weren't going to compete with the Communists in numbers of submarines. Now we've decided we're not going to compete in numbers of planes. You, perhaps the greatest authority on the subject, have just told us we're not going to compete in numbers of engineers and scientists.

Inasmuch as General Putts' testimony, at least in the opinion of the Chair, pretty well blasted the qualitative argument from the standpoint of our future relative qualitative effectiveness as against the Communists, I think the American people would be interested to know at what time, on what, and when we intend to make a stand to compete on a quality basis. At some time in our defenses we have to decide to make a struggle for superiority on something—else some day we will be in serious trouble.

Directing myself to the bottom of page 2 of your statement, are we to understand that when you say—

> They recognize the utmost importance of this education to the military power as well as the economic development of the country—

then going down to your next sentence—

> There's no doubt the Soviets have generated a respect and enthusiasm in these fields—

you are talking about the military fields; is that right?

Dr. KILLIAN. Yes.

GENERAL COMPARISON WITH SOVIETS

Senator SYMINGTON. Would you say from that that this interesting analysis of the vertical trend in education, does that give them an opportunity to throw in their shock troops in any place they want to?

Dr. KILLIAN. I don't think they are nearly as flexible in that as we are.

Senator SYMINGTON. Does it give them an opportunity to concentrate more on air power. Do you think our system for training engineers and scientists is nevertheless the better system?

Dr. KILLIAN. I think our system is the better system. I think the most fundamentally important thing in training scientists and engineers is to give them a fundamental versatility that will enable them to tackle many different kinds of problems.

Senator SYMINGTON. If their shortages are rapidly being handled under their system, and according to your own testimony 800 companies wanted 700 people at your university last year, how can you feel that the way we are doing it is best. The word "system" is a bad word because it might imply something between the free world and communism. Of course I don't mean that, but how can our system be meeting the challenge of the rising technological ability of the Soviet if at the same time we are having this increasing shortage in our own country?

Dr. KILLIAN. We must recognize that we have had a confluence of a number of trends that have been for a period to our disadvantage. One of them is our birthrate. The fact that we are in a period now where the low birthrate of the depression is just coming up to the threshhold of our colleges, so that we have a smaller pool of young people because of this birthrate cycle effect.

The Russians haven't had this same birthrate cycle, so we must recognize that we have a peculiar situation—at least not to my knowledge do they have. This has been a major factor in our present shortage, the fact we have had a smaller group of youngsters come along, but there have been other factors, too.

And I think by the kind of things I have proposed here, by giving incentives of scholarships, by wide public attention, by calling national forums to emphasize that we have shortages in these fields, we can begin to reestablish the flow.

There is another very encouraging thing that I can report here: I understand the big national scholarship programs like the national merit scholarships, the General Motors scholarships, national scholarships, that a very large number of the youngsters who win those scholarships are indicating that they want to go into science and engineering at the present time.

This is very encouraging and I think reflects the fact that we are turning the tide and are beginning to make progress, but we have got to keep working at it.

Senator SYMINGTON. When do you think, Doctor, that you will have some figures with respect to the turning of that tide?

Dr. KILLIAN. I think I could get them in a fairly short time.

Senator SYMINGTON. Maybe a later report that is coming out will be along those lines?

Dr. KILLIAN. It might be, yes.

SHORTAGE OF TECHNICIANS

Senator SYMINGTON. Now on page 4 you talk about the Communists having a serious shortage of technicians and not having the broad technical base comparable to this country or in Germany.

Dr. KILLIAN. Yes.

Senator SYMINGTON. If they are building more machine tools than we are, however, they are automatically taking up the slack in their technical base as their population gets more and more informed with respect to the use of those machine tools. Would that be a fair statement?

Dr. KILLIAN. I'm talking about a more sophisticated kind of technician than that.

Senator SYMINGTON. You talked about them being very good at the top, and then you talked about their broad technical base.

Dr. KILLIAN. Yes.

Senator SYMINGTON. I'm wondering what you meant by technicians.

Dr. KILLIAN. One of our growing needs in the United States is to have people who are trained at the level of the junior college or the vocational school, possibly high-school training as technicians, engineering aids and so on, and we have so far not developed as great a system in this country as England has, for example, in its field. This is one of the things that we need to push in our educational program,

training more people not as engineers but to be engineering aids and to back them up.

As I recall the figure, every engineer ought to be supported by 6 technicians or engineering aids to be most effective.

It is at this level that I am talking about.

Senator SYMINGTON. I think Senator Saltonstall pointed out that you did not mean they had more machine tools. You meant they were producing more.

Dr. KILLIAN. That's right. I think we have a great accumulation of machine tools and other equipment in this country that they probably can't begin to match.

Senator SYMINGTON. You talk about these new scholarships and you recommend the way to do it. You say "if not, the Congress should establish Federal scholarships."

Dr. KILLIAN. Right.

FEDERAL GOVERNMENT SCHOLARSHIPS

Senator SYMINGTON. Does that mean that in order to meet this challenge, this need, you feel if necessary the Government should enter directly into the educational field?

Dr. KILLIAN. In the form of scholarships.

Senator SYMINGTON. In the form of scholarships.

Dr. KILLIAN. Right, which the Government is already in through the National Science Foundation.

Senator SYMINGTON. I understand that, but this is an interesting statement.

Dr. KILLIAN. Yes; I would prefer to see private funds do this if they can be mustered in sufficient amount to do it; but if not, I think it's so important to do that it ought to be done by the Federal Government.

Senator SYMINGTON. That was the reason for my question. Now you say "recent studies have shown that we have come perilously close to becoming a nation of mathematical illiterates in a period when mathematics is an essential ingredient of air power."

Dr. KILLIAN. Yes.

SOVIETS GIVE MORE ATTENTION TO MATH AND SCIENCE

Senator SYMINGTON. Some of the statements that we have seen come out of Russia recently show that they have probably more interest in math and science than anything else they do.

Dr. KILLIAN. Right.

Senator SYMINGTON. Would you say now they are ahead therefore in this field with respect to youth; or are we ahead?

Dr. KILLIAN. I don't know the answer to that question. I think that they are doing some things that we are not doing that are going to get them ahead unless we improve our present circumstances.

For example, I have some figures here which indicate that this kind of curriculum in the schools below the college level is now true in Russia. Twenty percent of the total curriculum below the college level is devoted to mathematics in Russia.

All students have to take it.

All students are required to take 5 years of physics and 4 years of chemistry in the schools below the high-school level. This is a general requirement, but we have no universal requirements of that sort. I would not recommend that we do so, but I would recommend that we greatly strengthen our teaching in science and mathematics throughout the country in the secondary schools.

This information comes from a recent study supported by the Carnegie Foundation in New York.

It was undertaken by the educational testing service in Princeton on the teaching of mathematics. It is very revealing about the fact that we are weak in mathematics teaching at the present time.

Senator SYMINGTON. I remember former Senator Benton said he noticed a big crowd of children around a bookstore. He thought they were all fighting for some baseball book, or whatever their national game is; but found these children were all fighting to get a new physics book. Apparently they have that type and character of interest.

We are still a long way from that over here; aren't we?

Dr. KILLIAN. I haven't heard of any such custom.

Senator SYMINGTON. Mr. Counsel, have you any questions?

Mr. HAMILTON. Yes; I have a few, Senator.

ECONOMIC COMPETITION FROM SOVIETS

On page 2 of your statement, Dr. Killian, the second line from the top, you say:

> We face economic competition which will be a race in industrial technology.

Dr. KILLIAN. Yes.

Mr. HAMILTON. I wonder if you would mind elaborating on that briefly for the record?

Dr. KILLIAN. Well, I have a feeling just built up by impressions that I have received on all of the public discussion we have about Russia and education, and the Russian policy, that they are going to make a great drive to develop their industrial potential, producing consumer goods and all that which they will sell in the world markets.

They are also training scientists.

They are always training scientists and engineers that they can export abroad as a part of their own foreign-aid program, and so on, that will be very helpful to them in building their prestige and building their relationships with other countries. I would feel very strongly that they are going to so strengthen their industrial system that they can compete with great democracies.

Mr. HAMILTON. In that regard, Dr. Killian, on page 4, the third sentence of the first paragraph reads:

> Nor do they appear to have a broad technical base comparable in engineering instinct to the American or German base.

Dr. KILLIAN. Yes, sir.

Mr. HAMILTON. To what extent would you expect that they might be able to broaden whatever technical base they have down through the years if they continue the emphasis that they are now putting in the field of technology?

SOVIETS BROADENING TECHNICAL BASE

Dr. KILLIAN. I think they will very gradually broaden it, and we should not assume they would not.

Mr. HAMILTON. In a sense, I assume it is fair to say that America and Germany at the present time are heirs to a considerable period of development in this field——

Dr. KILLIAN. That is correct.

Mr. HAMILTON. That the Russians, because of the rapid development you have described, do not now have available.

Dr. KILLIAN. That is correct.

Mr. HAMILTON. But you would expect a broadening of their base.

Dr. KILLIAN. Yes, sir; I do.

WEAPONS SYSTEM EVALUATION GROUP

Mr. HAMILTON. In connection with your discussion of the weapons systems evaluation group, could you give the committee the benefit of your views as to the kinds of problems the group has encountered in the past which you feel it may be possible to overcome, by virtue of the new type of organization that you have described?

Dr. KILLIAN. One of the main problems the group has had is to recruit personnel of first-rate caliber. They have had a few people who have been first rate, but not enough, and they never have been able to bring their different groups up to critical size so that they can really go all out and do a real job on the problems they might grapple with.

This has all come about because of the factors that you are familiar with; the difficulty of coming and working in a restrictive field of this kind when you cannot publish and you have no way of demonstrating your professional advancement; the kind of thing that obtains in a lot of classified work.

Our problem is to find ways of providing the incentive, the recognition, the understanding by the scientific community, of what these people are doing so that they will feel they will have the recognition and the rewards that are natural.

Mr. HAMILTON. Since we have had very little testimony about the Weapons System Evaluation Group in the hearings thus far, I wonder if you could briefly describe for the record, if you are in position to do so, where that group fits in organizationally in our Defense Establishment.

Dr. KILLAN. As I recall, this group was provided for in the Unification Act. It was suggested, I think, originally by Mr. Forrestal. And it was conceived of as a group which would be available to the Joint Chiefs of Staff to undertake analytical work which would draw upon mathematical, scientific methodology and resources in analyzing the many kinds of complex problems of tactics and strategy that we face, and in analyzing weapons systems.

We had during the last war many great successes in this field of operations research in this country; so did England in its field; and the Navy, the Army, and the Air Force all developed operations analysis groups.

As a matter of fact, each of these Services now has its own groups. The ORO in the Army is an example. The Navy has a group. The Air Force has two groups, including the Rand Corporation, which

is largely devoted to this kind of thing, working on Air Force problems.

All of these have made important contributions by applying mathematical analysis to complex problems where you have many variables and you need to use mathematical techniques to resolve them.

This is an important new development in military planning and military analysis that has come about since the start of the last war.

It was felt that it was important to have this kind of analysis available at the very core of our Joint Chiefs planning in Government, and this was provided for by the establishment of this group, and it had a number of different directors, civilian directors of research, all very able men.

And all of them have felt that the real problem was to find a way to recruit adequate numbers of first-rate people.

As a result of a number of studies, including again the Research and Development Report of the Hoover Commission, which recommended that this be contracted out in its management, the effort was made to set up this corporation, on which I reported here, to do this job, in the same way that the Air Force has set up the Rand Corporation, the AEC has set up Associated Universities, incorporated to run the Brookhaven National Laboratories. I can report to you that since this corporation was established, since the private direction of this was taken over so far as the civilian part is concerned, there has been steady augmentation of the civilian staff, and we are really making headway.

Mr. HAMILTON. Thank you, sir.

One final question, if I may, and that is this:——

Dr. KILLIAN. Yes.

STRESSES URGENCY

Mr. HAMILTON. Would I be right in the inference I draw from the note of urgency which you set in your paper, that you feel that urgency because of the lead time in the field of scientific research and development?

Dr. KILLIAN. That is right.

Mr. HAMILTON. The time between an effort made now and its realization in terms of weapons systems?

Dr. KILLIAN. That is right.

Mr. HAMILTON. That is all.

Senator SALTONSTALL. Just two other questions.

NATIONAL COMMISSION ON AERONAUTICS

I forgot to ask you your opinion about the National Commission on Aeronautics, Dr. Hunsaker's commission.

Dr. KILLIAN. I should have said that in my paper.

I think that has been one of our most remarkable achievements in the field of research and development. The concept of the National Advisory Committee on Aeronautics, which goes back to the Wilson administration, I believe—I think I am right about that—whereby you have a group of our first-rate civilian experts constituting a board of directors, and you have a group of Government laboratories operating under its general policy direction, has been a very successful research undertaking, and this is very important in this total military picture,

and particularly in the air picture, because they have made great strides.

Senator SALTONSTALL. And their work is not being duplicated?

Dr. KILLIAN. I have not looked at the list of research projects, but I would say that their work is fundamental and basic to our total airpower development in the United States, and exceedingly important.

Senator SALTONSTALL. And the other question I think you probably already covered in what you said to Senator Symington.

VERSATILITY VERSUS SPECIALIZATION

The vertical type of scientific education makes it very difficult for that man to be a versatile scientist.

Dr. KILLIAN. Yes; that is right.

Senator SALTONSTALL. And the great success of our education, certainly in World War II and in the development of the atomic bomb and many of the other developments, was due to the versatility of the educated scientist——

Dr. KILLIAN. That is right.

Senator SALTONSTALL. Going into brandnew fields, not only brandnew fields of research but also brandnew fields for him, and then coming up with results.

Dr. KILLIAN. That is right. By "brandnew fields," a physicist will go into some other part of physics, perhaps, or he may go into engineering.

Senator SALTONSTALL. That is what I meant.

Dr. KILLIAN. Or some form of applied science. But it is a very great advantge in training a man to give him as broad a base as possible, because you cannot possibly forecast or anticipate what the applied field of great importance can be.

Senator SALTONSTALL. And that versatility we cannot afford to lose.

Dr. KILLIAN. We cannot afford to lose it; that is one of our great strengths, and we should cultivate it more.

Senator SALTONSTALL. Thank you.

Senator SYMINGTON. Senator Duff?

Senator DUFF. Doctor, I would like to ask one final question.

Dr. KILLIAN. Yes.

SOVIET RESEARCH INSTITUTES

Senator DUFF. Do the Russians in their manufacturing enterprise have extensive research teams comparable to those maintained by private enterprise in the United States?

Dr. KILLIAN. This is all a government operation, as far as I know, in Russia. But the Ministry of Aircraft Production in Russia has its own institutes devoted to research. They are Government institutes, but their industry is Government, too, so that these feed right into that industry.

Senator DUFF. For example, what I meant was, places like du Pont, and Standard Oil of New Jersey, and General Motors, and so on, have tremendous research going on all the time.

Dr. KILLIAN. That is right.

Senator DUFF. Is that characteristic of their industry all the way through?

Dr. KILLIAN. In the form of the institutes that make up these ministries, they will have a whole category of research institutes devoted to aspects of the chemical industry or the aeronautical industry, and so on, so in that sense they do have a comparable setup.

But it is not managed by private enterprise. It is all a part of the Government monopolistic organization.

Senator DUFF. Therefore, it would not be likely to have the same initiative as you would in private enterprise.

Dr. KILLIAN. No; I would again favor our system very much. But it can be directed, it can be focused toward Government objectives, toward military objectives, in a way that is harder for us to do, but not impossible for us to do.

Senator SYMINGTON. Dr. Killian, we never are going to lick the problem by talking about it in generalities; is that not so? I make that statement with no thought in mind, except we must face up to the problems you yourself have delineated in this paper.

SOVIETS CUT LEAD TIME

For example, the fact they are years ahead of us in shortening the lead time in planes. Did you not say that in 2 or 3 years they put a plane in production?

Dr. KILLIAN. I say that apparently the evidence shows they have been able to achieve that.

Senator SYMINGTON. Yes.

Dr. KILLIAN. I think we have been able to do some things faster than they have.

Senator SYMINGTON. And they did it by concentration, did they not, by concentration on that particular problem?

Dr. KILLIAN. Well, by regimentation; concentration, if you will.

SOVIETS CONCENTRATE ON POWER OBJECTIVES

Senator SYMINGTON. There was an article recently in one of our weeklies which said their industrial complex, whatever it is, is concentrated primarily on power, whereas our industrial complex is concentrated primarily on comfort and a better standard of living.

Regardless of the efficiency prevailing in one of our great oil companies, as against the efficiency of a Russian Government oil company in research and development, 90 percent of the work in one of our oil companies is on improving the gasoline for peacetime consumption and comfort, whereas 90 percent of theirs is improving, say a jet engine fluid. The chances are then that they might be about even with us so far as the net result in defense effort of what comes out of those two research and development organizations. Would that be a fair statement?

Dr. KILLIAN. I would have to add a footnote to that to say that I think the enterprise that is built into our system, the initiative that is built into it, will in the long run, if we plan well, yield us more and yield us greater strength than their system of regimentation. This is instinctive.

Senator SYMINGTON. Nobody could argue with you on that philosophy.

Dr. KILLIAN. That is right.

Senator SYMINGTON. I was trying to establish reasons why you felt they were closing this qualitative gap, based on your own statement in your own paper.

Dr. KILLIAN. Yes, sir. In certain fields where they really have felt they had to throw everything in to do a given job, they——

Senator SYMINGTON. How do you know they threw everything in?

Dr. KILLIAN. I just assumed it.

Senator SYMINGTON They might have thrown in more or less than we do, yet gotten ahead of the development we did, shortening lead time, for example. Is that a fair statement?

Dr. KILLIAN. I think that purely with their relative backward history of technology, they have had to do an extraordinary job of concentrating on a few things.

Senator SYMINGTON. And that they have done?

Dr. KILLIAN. And they have done it.

Senator SYMINGTON. The record shows they have done an extraordinary job, does it not?

Dr. KILLIAN. Yes; it does.

"CLOSING THE GAP"

Senator SYMINGTON. And part of the reason for these hearings is, because of the extraordinary job they have done not only in the field of hardware but in the fields of relative scientific education, we have become apprehensive, have we not, because of the closing of that scientific education gap?

Dr. KILLIAN. Yes; we are.

Senator SYMINGTON. Is that not the basic reason we are all here this afternoon?

Dr. KILLIAN. Yes.

TOTAL VERSUS ITS PARTS

Senator SYMINGTON. On your last page you say:

*** * * one factor which to my mind today is of overriding importance: that is to do those things now within our grasp and means to achieve a maximum degree of readiness. This is as of today more important than any discussion of budgets or number of bomber wings—**

presumably you mean number of submarines and everything else.

Dr. KILLIAN. Yes.

Senator SYMINGTON (continuing):

or trying to match or exceed Soviet plane production or R. and D. policies.

What do you mean by that?

Dr. KILLIAN. I mean, if I may describe it this way, that I think we need first of all to consider our military problem as meeting our American needs to do the job that we visualize we must do; and that that may be a different thing from trying to match a plane production here or a given Russian Production there.

It means an integrated system. This goes back to my philosophy of the importance of having an integrated strategical concept that serves our purposes, and I think you have got to look at this total power that you are planning for and generating, rather than to look at the pieces of it.

The pieces of it are important, but unless you relate the pieces to the total, you may not achieve maximum strength. This is my opinion, and I speak again of the systems concept.

Senator SYMINGTON. You are a great expert in this field. In order to have any total, however, you have to have a certain number of component parts, do you not?

Dr. KILLIAN. We certainly do.

Senator SYMINGTON. And we have been getting a steady stream of thought why it is not important for us to match the Communists in this field or that field, and so on.

Would you give us any field in which you think it is important that we not only match, but are superior to the Communists?

Dr. KILLIAN. Yes, sir.

Senator SYMINGTON. I am not talking of very important fields like economic strength or spiritual strength. I am talking about the boys who have to go out to fight the wars to protect us in case we are attacked.

Is there any field you think we should be superior in, from the standpoint of military efficiency and effectiveness?

HOPES TO HAVE QUALITATIVE SUPERIORITY

Dr. KILLIAN. I would hope that we would be superior in all fields in terms of a qualitative superiority. That is different from a numerical superiority.

Senator SYMINGTON. Well, you would not hope that we would be superior in the field of soldiers, would you?

Dr. KILLIAN. To do the job we need to do, that does not mean we want to match their great land armies, necessarily.

Senator SYMINGTON. We don't want to match their great land armies. We have all agreed we don't want to match their great submarine fleet; is that correct?

Dr. KILLIAN. In quality to do our job, I would hope that we did, but not numerically.

QUANTITY ALSO ADDS TO STRENGTH

Senator SYMINGTON. Well, our job is to be able to defend against their growth; is it not? We have figures here in the committee, which we cannot release, showing that their submarine strength is growing very rapidly. It is a published fact they already have over 400 submarines. Where and when do we decide that because we have 1 or 2 qualitatively superior submarines we don't have to build any more, as against their growing hundreds? This is important, because the so-called killer submarines are excellent for destroying enemy submarines.

Dr. KILLIAN. The question that I would raise, and I have no expertness on the submarine——

Senator SYMINGTON. Doctor, now bear with me; you are pretty much of an expert in this field.

Dr. KILLIAN. No, sir; I am not, in this field.

Senator SYMINGTON. You and I were together once in this field of technical armament. You are a great expert.

Dr. KILLIAN. No; I would say our problem is to have the kind of submarines to do the kind of mission we might have to do.

Senator SYMINGTON. I didn't hear that.

Dr. KILLIAN. This may be a different number from the submarines the Russians need for their mission.

Senator SYMINGTON. We have agreed that quantitatively we have 19 divisions, 14 trained, and they have 175 divisions plus a couple of hundred Chinese divisions.

Captain Searcy, has the latest figure been released of the number of Communist submarines?

Captain SEARCY. No, sir. It is classified.

Senator SYMINGTON. We have far less than they and the discrepancy is growing, but we are going to send out our boys in these qualitative submarines, hundreds and hundreds less than they have.

Now we come to the point where an Air Force publication says:

> Second-rate Air Force now deficient from the standpoint of numbers.

Then you have here one sentence, in which you say:

> Simply adding more and more planes does not necessarily give us optimum strength.

But adding more planes of high quality or more submarines of high quality gives us more net strength; does it not?

Dr. KILLIAN. Yes; it certainly could. But the real problem is, as I see it, Are these things all a part of a coherent whole that gives us a maximum power?

What I am talking about it total superiority, which must be made up of a lot of different elements, but which may be a different grouping and a different distribution of numbers than some opposing power might have. I am getting into an area now of strategy and tactics that I don't——

Senator SYMINGTON. You are an expert in this field, one of the experts, in my opinion, because you see it all, and many people only see part of it.

Dr. KILLIAN. No, sir.

Senator SYMINGTON. If you are going to send a boy out to defend his country, you have the desire, do you not, to give him the best possible equipment?

Dr. KILLIAN. I certainly do.

Senator SYMINGTON. And the best total superiority that you could give him?

Dr. KILLIAN. I certainly do.

CAN UNITED STATES AFFORD TO DEFEND ITSELF?

Senator SYMINGTON. So what we are really talking about now, are we not, is that we cannot afford to have great numbers of things without seriously jeopardizing that from which our military strength comes; namely, our economy. Is that not a fair statement?

Dr. KILLIAN. I think so.

Senator SYMINGTON. All right.

Now we get down to where we can feel the discussion. We do not want necessarily to have a complete superiority. We hope we can have qualitative superiority, but we must not hurt our economy.

With that premise—is that correct, the way I have stated it?

Dr. KILLIAN. I do not know whom you are reporting.

Senator SYMINGTON. Well, I thought I just repeated the question that I asked you before. Let me repeat it again.

Dr. KILLIAN. Yes.

Senator SYMINGTON. If you do not think that it is important for us to have total superiority——

Dr. KILLIAN. I do think it.

Senator SYMINGTON. You do think it?

Dr. KILLIAN. I certainly do.

Senator SYMINGTON. Well, now, in total superiority, would you not say that superiority in number of planes is also important; number of submarines; number of troops?

Dr. KILLIAN. It may well be important, but unless you relate that to some overall strategic plan, I don't think that you can answer this question.

Senator SYMINGTON. Is there any better overall strategic plan than planning how to defeat your enemy in case you are attacked?

Dr. KILLIAN. No, sir.

Senator SYMINGTON. And if we have to figure how to defend ourselves against any type attack he may make against us; and inasmuch as he is the aggressor by philosophy and by experience, he only has to concentrate on one type of attack, whereas we have to concentrate on all defenses against all types of attack. Then is it not important for us to also consider numbers as well as this somewhat seductive approach to the qualitative problem?

QUANTITY IMPORTANT: INTEGRATION VERY IMPORTANT

Dr. KILLIAN. Numbers are certainly of very great importance. But, without looking at the total planning, I do not think I could venture to say that a given number of bombers was the right number or not.

What I am saying is, I think we ought to have a broad system concept for our defense which seems to give us, in terms of the weapons that we use, in combination with the planes that we have, the backup that we have, and all of those things, military superiority.

And I do not think this is a matter of matching one item against another item from another country, necessarily. It might be.

Senator SYMINGTON. I agree with that. But we have gotten into a habit down here, perhaps sincere, perhaps subconscious; and that is, we constantly compare our prototypes with Communist mass production.

You have given one reason for that. You showed the relatively short time in which the Communists handle their lead time situation.

I wonder if I understand what you mean by this sentence:

> Simply adding more and more planes does not necessarily give us optimum strength.

Do you think we are building too many airplanes now?

Dr. KILLIAN. I do not know.

Senator SYMINGTON. Or too few?

Dr. KILLIAN. I really don't know. I haven't looked at this picture in any detail, and my judgment would not be valid.

Senator SYMINGTON. Then finally, in this line of questioning, if you are going to concentrate, as you say, to do those things now to achieve a maximum degree of readiness——

Dr. KILLIAN. Yes.

Senator SYMINGTON. Do you believe that requires more integration of the Services, especially as a result of the development in the missile field?

Dr. KILLIAN. I do.

Senator SYMINGTON. Would you care to expand on that?

Dr. KILLIAN. Well, I mentioned one item in my paper. I think we have got to go even further, still, in the integration of our complete air-defense system, so that things are really tied together and can function as a complete system.

Senator SYMINGTON. Now, Doctor, we have been through the summer studies, we have been through the various reports, but fundamentally is there any reason why we should have more integration of our defense than we have integration of our offense?

Dr. KILLIAN. No, not at all.

Senator SYMINGTON. Would it not all tie in together pretty well?

Dr. KILLIAN. It certainly does.

Senator SYMINGTON. War is still firepower and the ability to deliver; is it not?

Dr. KILLIAN. Yes.

Senator SYMINGTON. "The fustest with the mostest."

Dr. KILLIAN. That is right. General Forrest.

Senator SYMINGTON. Mr. Counsel?

Mr. HAMILTON. Nothing.

DESIRE TO BE STRONG

Senator SALTONSTALL. Mr. Chairman, I would like to ask a question. Do I understand you, Doctor, to mean that what we want to have is overall strength, militarily, economically, and spiritually, so that no nation will dare to attack us because of our power to retaliate devastatingly?

Dr. KILLIAN. That is right. I feel this very strongly.

Senator SALTONSTALL. I have nothing more to say.

Dr. KILLIAN. That is right. And I have tried to say here that I think that one of our great immediate problems is to make sure that this whole Nation is alert in every component to make sure that we can deal with any eventuality that might take place. And that it is awfully important, to make sure that we are protecting what we have, and using it in the most effective possible way.

Senator SYMINGTON. Senator Duff?

SUBMARINE PROBLEM VERSUS CARRIERS

Senator DUFF. The chairman, Doctor, has mentioned the number of submarines today. Well, part of the components that we would have on the sea, I assume, would be the large number of aircraft carriers that we have, as to which, so far as I know, there is no evidence that the Soviets have any. And would that not be one of the components that adds up to the total of which you are speaking?

Dr. KILLIAN. Yes. This is an illustration of your having to look at the total range of means that you have, and it may be that we made a decision to use carriers instead of submarines, or some other kinds of vehicle instead of this vehicle, in order to get the power that we want.

That is why I do not think you can look at submarines alone, without looking at the total picture.

But I would also add that I think what we know about the Russian submarine development means we have a very great problem in knowing how to counter that development.

Senator SYMINGTON. Excuse me, Senator, are you finished?

Senator DUFF. Yes.

Senator SYMINGTON. I am very glad that we have superiority in carriers. I won't give the carrier figure, but it is relatively very small as compared to the superiority in hundreds the Communists have in submarines.

Let me ask you this one final question.

Dr. KILLIAN. All right.

QUESTION OF PRESENT PLANS AND PROGRAMS

Senator SYMINGTON. Do you feel, based on your experience, we have the right plan now, so that under present programs we are going to continue to be able to protect this country adequately from the only possible enemy?

Dr. KILLIAN. Again, I would have to say, Senator, I have not looked at the total plan, I have not seen any war plans, I do not know what the total distribution among the services is, or anything of the sort.

I certainly think we are moving in the right direction. That is the best I can do. And I think it would be wrong for me to make a public statement when I am not an expert or competent in the field.

APPRECIATION

Senator SYMINGTON. Doctor, the committee is very grateful to you for coming down here and giving us the benefit of your experience.

The only thing I completely disagree with you on is you are too modest.

Dr. KILLIAN. You are very kind.

Senator SYMINGTON. And I am sure the country is grateful for the work you have done in this field.

Thank you very much.

We will recess now until tomorrow morning at 11 o'clock.

(Whereupon, at 4: 15 p. m., the subcommittee recessed, to reconvene at 11 a. m., Thursday, June 21, 1956.)

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